Using Roger in the Homes of Children with Hearing Loss

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Learning outcomes

- Participants will be able to list 2 possible communication benefits of using RM systems in homes for children with hearing loss.
- Participants will be able to list 2 benefits perceived by caregivers when using RM systems in the home environment.
- Participants will be able to list at least one possible limitation of using RM systems in homes of children with hearing loss.
Presentation Outline

• Introduction - Communication needs for children with hearing loss
• Studies on remote microphone system (RM system) use at home
• Discussion
• Limitations of RM system use at home
• Questions first part
• Remote microphone systems and brain and speech in noise perception skills development
• Questions second part

SHOULD CHILDREN WITH HEARING LOSS USE RM SYSTEMS CONSISTENTLY AT HOME?
"For the developing child, optimal learning and communication require clear speech, developmentally-appropriate language, and received speech levels that are at least 20 dB above those of interfering noise and reverberation."

Remote Microphone Hearing Assistance Technologies for Children & Youth from Birth to 21 Years (AAA, 2011)

"ANSI standards recommend a signal-to-noise ratio (the difference between the teacher's voice and the background noise) of at least +15 dB at the child's ears for the classroom setting"

American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools
How noisy are the homes of children with hearing loss?

“With few exceptions, the more parents talked to their children, the faster the children’s vocabularies were growing and the higher the children’s IQ test scores at age 3 and later. The most important aspect of children’s language experience is its amount.”

Quantity

Hart & Risley, 1995
The Contribution of Early Communication Quality to Low-Income Children’s Language Success

Kathy Hirsh-Pasek¹, Lauren B. Adamson², Roger Bakeman³, Margaret Tresch Owen⁴, Roberta Michnick Golinkoff⁴, Amy Pace⁴, Paula K. S. Yust⁴, and Katharine Suma²
¹Temple University, ²George Mason University, ³The University of Texas at Dallas, and ⁴University of Delaware

“Our results confirm that both the quantity of language input and the quality of parental sensitivity affected language outcomes. Research spotlights the powerful contribution of the quality of the communication foundation co-constructed by the caregiver and the child”

Hirsh-Pasek et al, 2015

Children learn language coming from a distance

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Overhearing is especially important for word learning by 2 ½ years of age

- Tomasello & Barton, 1994
- Akhtar, 2005
- Bloom, 2000

**Remote microphone systems (RM System)**

- Hearing assistance technology (HAT) that:
  - Improve signal-to-noise ratio and speech perception in noise (e.g., Schafer & Thibodeau, 2006; Bertachini, 2015)
  - Provide access to speech coming from a distance
  - Increase opportunities to access more quantity and quality language
“Understanding communication access needs in the home environment is important to assist family members in determining situations in which HAT should be implemented as well as situations where HAT use would be inappropriate”

AAA, 2011

Few studies of RM system use in homes

Longitudinal Study of FM System Use in Nonacademic Settings: Effects on Language Development
Mary Pat Moeller, Kris Frisbie Donaghy, Kathryn Laudin Beauchaine, Dawna E. Lewis, and Patricia G. Stelmachowicz

Using Propensity-Score Matching to Address Clinical Questions: The Impact of Remote-microphone Systems on Language Outcomes in Children who are Hard of Hearing

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continued
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RM system use in homes of children with hearing Loss

- Impact on Caregiver Talk Quantity
- Impact on Child-Directed Speech Quality
- Impact on Child Responsiveness & Engagement
- Caregiver Perceptions
Purposes of the Studies

- To investigate the effects of the use of RM systems in home environments of children with hearing loss in terms of:
  - Access to quantity of language produced by caregivers
  - Access to quality of language (Child-directed speech, CDS)
  - Number of repetitions and alerting phrases produced by caregivers
  - Caregiver perceptions

Methods: Participants

- 10 families of children with permanent hearing loss ranging from mild to profound (BEPTA = 72dB)
- Ages: 2;6 to 6;4 (Average = 4;1)
- Hearing Technology: 2 HAs, 6 CIs, 1 bimodal (HA + CI) and 1 BAI (soft band)
- Key caregivers: 5 mothers, 4 fathers, 1 grandmother
- 7 English-speaking and 3 Spanish-speaking families
Methods: Equipment and materials

- LENA: Digital Language Processor
- RM System (Phonak ROGER)
- FM Listening Evaluation Checklist (Johnson, 2003)
  - Quiet
  - Auditory only
  - Distance
  - Noise
  - Total Score
- RM System Caregivers Survey

Methods: Procedures

NO-RMS WEEKEND
- LENA DLP on child
- LENA DLP on key caregiver
- FM Listening Evaluation Checklist

WEEKENDS WERE COUNTERBALANCED

RMS WEEKEND
- RMS
- LENA DLP on child
- LENA DLP on key caregiver
- FM Listening Evaluation Checklist
- RMS Caregivers Survey
- Families used the RMS three days prior to the RMS weekend – Novelty effect
Caregiver talk received by the child

All talk produced by the caregiver

VERY DIFFERENT SCORES = LARGE DISTANCE BETWEEN CAREGIVER AND CHILD

SIMILAR SCORES = REDUCED DISTANCE BETWEEN CHILD AND CAREGIVER
EQUAL SCORES = NO DISTANCE BETWEEN CHILD AND CAREGIVER

Methods: Procedures

- LENA DLP on Child
- LENA DLP on Key Caregiver
- RMS on Key Caregiver
Child-directed speech (CDS) produced with and without the RM

RQ1. Is there a difference between the **number of words** as well as the **amount of CDS** caregivers produce when using and when not using an RM system?

**Quantity**

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RQ2. Do caregivers produce a **greater proportion of words** as well as a greater proportion of **CDS** from a **distance** when using an RMS than when not?

![Bar chart showing quantity of words and CDS with and without RMS]

- **10% more words**

RQ3. Does an RM system provide a child with **more access to caregiver talk** as well as **CDS** in the home than when not using an RMS?

![Bar chart showing quantity of CDS and words per minute with and without RMS]

- **12% more words/ min**
- **57% CDS**
<table>
<thead>
<tr>
<th>Survey question</th>
<th>Qualitative category</th>
<th>Responses from families (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Under what circumstances did the RMS work best?</td>
<td>Talking from distance</td>
<td>80  70  60  50  40  30  20  10 0</td>
</tr>
<tr>
<td>2. Did you notice any communication difference in your child when using the RMS?</td>
<td>Increased responsiveness</td>
<td>90  80  70  60  50  40  30  20 10 0</td>
</tr>
<tr>
<td>3. How did your child react when listening to sound coming from a distance?</td>
<td>Very Confident</td>
<td>90  80  70  60  50  40  30  20 10 0</td>
</tr>
<tr>
<td>4. Were there any changes in your child’s behavior when using the RMS?</td>
<td>Very Positive Experience</td>
<td>90  80  70  60  50  40  30  20 10 0</td>
</tr>
<tr>
<td>5. Did you find any difficulties when using the RMS?</td>
<td>Yes*</td>
<td>80  70  60  50  40  30  20  10 0</td>
</tr>
<tr>
<td>6. How confident were you with the technology?</td>
<td>Very Confident</td>
<td>90  80  70  60  50  40  30  20 10 0</td>
</tr>
<tr>
<td>7. In general, how would you rate your experience using the RMS during the weekend? (1 = very poor, 5 = very positive)</td>
<td>(Very) Positive</td>
<td>90  80  70  60  50  40  30  20 10 0</td>
</tr>
</tbody>
</table>

Note: RMS = remote microphone system.

*Difficulties with the RMS reported by families included equipment being uncomfortable for the child to wear, difficulty remembering when to mute and unmute the equipment, inconvenience of wearing the extra device (neckloop for bone-anchored and cochlear implant), and siblings wanting to play with the transmitter.

**Caregiver Perceptions Questionnaire**

![Bar chart showing differences in maximum score between No RMS weekend and RMS weekend for different questionnaire domains: Quiet, Auditory Only, Noise, Distance, and Total Score.](chart.png)

FM Listening Evaluation Questionnaire (Johnson, 2003)
STUDY 3

Number of repetitions and alerting phrases produced by caregivers with and without the RM system

RQ. Do caregivers reduce the number of repetitions and alerting phrases they use when talking from a distance when using the RM system in the home?

Parameters

- Casual Rep.
  For example: “How does the cow say? Mu, mu, mu…”

- Intentional Rep.
  For example: “Bring me the red ball. Not the red doll, the red ball”

- Alerting Phrases
  For example: “Come here” or “Hey Mark!”

Total Score
RQ. Do caregivers reduce the **number of repetitions** and **alerting phrases** they use when talking from a **distance** when using the RM system in the home?

**Discussion**

When not using the RM system in the home

**Children:**
- **Might miss** a significant amount of caregiver talk (~5300 words/day – 42% of caregiver talk)
- **Might miss** a significant amount of child-directed speech (12%)
- This language could potentially be accessible through the use of an RM system, thereby promoting learning

Thompson, Benítez-Barrera, Angley & Tharpe, (2018)
Discussion

When using the RM System in the home:

Caregivers:
- Produced the same amount of talk as well as the same amount of CDS than when not using an RM system
- Produced **higher amount of talk from a distance** than when not using the RM system
- Produced the same amount of CDS from a distance as when not using the RM system
- Significantly reduced the number of repetitions and alerting phrases from a far distance
- Indicated high levels of acceptance towards the technology and reported auditory and communication changes in their children with hearing loss

Conclusion

- **The use of an RM system in the home could provide benefits in the communication environment of children with hearing loss**
- Exposure to more language quantity and quality is associated to better language skills later in life (Hart & Risley, 1995; Hirshek-Pasek et al., 2015).
- Moreover early access to language is associated to an improved neural language processing as well as the development of cognitive and academic skills (Romeo et al., 2018)
- Therefore, the use of an RM system in the home could provide auditory, language and communication benefits for children with hearing loss (Curran et al., in press)
SHOULD CHILDREN WITH HEARING LOSS USE RM SYSTEMS CONSISTENTLY AT HOME?

SHOULD WE RECOMMEND FAMILIES TO USE THE RM SYSTEM AT HOME?

Caution

- Access to excessive or inappropriate speech - Disruptive?
- Limited access to speech from other speakers
- Reduced access to distance and localization cues
- No information on the impact of prolonged of an RM system in the home at the cortical, auditory and language development level.
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SPEECH PERCEPTION IN NOISE SKILLS

PRACTICE

VS

CLARITY

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HOW DO WE DEVELOP “SOPHISTICATED AUDITORY MAPS”?

• ANIMAL STUDIES
  • Sensory deprivation
    • Visual domain (e.g., Hubel and Weisel, 1970) and auditory domain (e.g., Kral, Yusuf & Land, 2017; Kral, 2007)
    • Impact on brain development – Cross-modal reorganization
  • Enriched sensory experience (e.g., Greenough & Volkmar, 1973; Eggermont, 2008)
    • Thicker cerebral cortices
    • Larger neuronal cell bodies
    • Higher number of synaptic connections

HOW DO WE DEVELOP “SOPHISTICATED BRAIN MAPS”?

• HUMAN STUDIES
  • Sensory Deprivation – Children with hearing loss
    • Impact on brain development – Cross-modal reorganization (e.g., Sharma et al., 2014)
    • Language development (e.g., Yosinaga-Itano et al., 2017)
  • Enriched sensory experience - Music
    • Enhanced sub-cortical and cortical responses to sound and speech (e.g., Parbery-Clark et al., 2009)
    • Speech-perception in noise skills (Patel., 2013; Sanju & Kamur, 2016, Strait et al., 2012)
    • Working memory skills (Strait et al., 2012)

EXPERIENCE-DEPENDENT MECHANISM
(Greenough et al., 1987)
SPEECH PERCEPTION IN NOISE SKILLS

PRACTICE

VS

CLARITY

Child with hearing loss

Child with normal hearing

QUIET

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Child with hearing loss

Child with normal hearing

+15dB SNR

Child with hearing loss

Child with normal hearing

+10dB SNR

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Child with hearing loss

Child with normal hearing

+5dB SNR

Child with hearing loss

Child with normal hearing

0dB SNR
Child with hearing loss  Child with normal hearing

-2dB SNR

Child with hearing loss  Child with normal hearing

-5dB SNR

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Better speech in noise skills even when the RMS is not used...
Short-term sensory cortical responses with RM system

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THANK YOU!

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